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Study of the Properties of Cellulose Obtained from Amaranth Stem

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Abstract: There is an opportunity to extract cellulose from the wastes of medicinal and agricultural plants and use them as a good raw material for making paper, which is important for non-forestry countries. Within this study, the kinetics of the process of cellulose extraction from amaranth stem was studied, and the properties of the obtained cellulose were studied. Based on the conducted experiments, a technological mode of cellulose extraction from amaranth stems is proposed.

Keywords: amaranth stem, degree of whiteness, degree of polymerization, wood cellulose, α-cellulose.

Introduction. Fibrous cellulose pulp in the composition of medicinal and agricultural plant wastes is considered a good raw material for paper production. Since these raw materials are bulky, their transportation and logistics require on-site processing of the cellulose pulp. Obtaining cellulose from the waste of one- and many-year-old non-wood plants, searching for opportunities for paper production based on local fibrous raw materials are considered urgent tasks. As a result of the conducted research, the possibility of obtaining cellulose from amaranth plant waste by alkaline method was investigated [1].

The technological features of the local amaranth plant were studied in order to propose a technology of cheap, rational use of raw materials of local plants for the paper industry in countries where there is no forestry.

Amaranth belongs to the Amaranthus family, which includes more than sixty species. Native to South America, it has been cultivated for seed for 8,000 years. Amaranth is widespread from South America to North America, India and from there to the world through Asian countries. Now there are many varieties of amaranth in India and China, these countries are the secondary homeland of amaranth. In these countries, the amaranth plant is widely used in local medicine, national cuisine and industry. Amaranth flower is a small flower, pink, dark pink, red and dark red, and because it reminds of a cock's crown, it is called "flower flower" among our people. Amaranth is an annual plant that is cultivated in various directions, including: vegetable (Amaranthus gangeticus, Amaranthus mangostanus), grain (Amaranthus caudatus, Amaranthus paniculatus), ornamental and (Amaranthus blitum) fodder crops [2].

In our republic, amaranth is grown only as an ornamental crop. The main reason for this is that its velvety flowers retain their charm for a long time, they are resistant to external influences and

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can survive for several months without water. Perhaps for this characteristic, amaranth was given the name of immortal flower.

In addition to the organic matter that forms the basis of wood, it also contains mineral substances that produce ash when heated. These minerals are of great importance in the development of trees and plants. They are present in a dissolved state in tree wine or in tree tissue.

The amount of ash obtained by burning a tree depends primarily on its type. The amount of ash in firewood can be up to 1.5-2% due to its contamination and the presence of roots. The amount of ash in a tree varies widely. The amount of ash depends on the growing conditions, place, season, age, soil layer of the tree. If the sample for determination of tree sol is taken in the spring (when wine flow is accelerated in the tree), the amount of sol will be higher than when the sample was taken in autumn [3].

Since cellulose is a rigid chain polymer, various changes occur in its structure and properties. Depending on the principle of operation of the shredder, in some cases, some liquids are also added in order to carry the level of cellulose grinding deeper. The appearance of the resulting cellulose particles also depends on it. In particular, when cellulose fibers are crushed in an aqueous medium, fragmentation occurs along the fiber direction and cellulose particles with a high degree of asymmetry are formed. When grinding in air and non-polar liquids (hydrocarbons), fragmentation goes in the transverse direction to the fiber axis, as a result, the asymmetry of the particles decreases dramatically [4].

As the cellulose particles became smaller, the amount of alpha-cellulose also decreased. If the amount of -cellulose in the original cellulose was 98%, it decreased to 89% in the fraction with particle size smaller than 315 μm. So, during the process of compression, crushing and grinding of cotton cellulose fibers in the device, the part that dissolves in 17.5% solution has gradually made up to 9%. However, the value of the molecular mass of cellulose has not decreased much, and the degree of polymerization of powdered cellulose is between 620-850, which means that it is considered sufficient to ensure its operational properties [5].

In order to carry out the mechanochemical bonding reaction with cellulose, it is necessary to place the molecules of substances with a high ability to react as close as possible to the cellulose macromolecule.

The molecular mass of cellulose is considered one of the important indicators and serves as a factor determining the quality of the products obtained from it. Cellulose is considered a linear homopolymer consisting of identical units, and is usually evaluated by the degree of polymerization, that is, the number of units in macromolecules [6].

Methods and methodology of the research: physic-mechanical and physic-chemical research has been done.

Creation of technology of obtaining semi-ready product from secondary resources and also to create the technology of producing papers from local raw material. It is studied to take cellulose from amaranth plant and studying peculiarities of obtained cellulose as well as to research the process of obtaining paper from amaranth's cellulose.

Experimental results and their discussion. Alkaline production of cellulose from amaranth stems was carried out in the following sequence: amaranth plant waste was cut into 1-2 sm lengths and heated at 100^0C for 100, 120, 140, 160 minutes, with 5.0 sodium caustic; 10.0; It was boiled in 15.0, 20% solutions, the filter was washed in a sieve, and dried.

Equipment used for obtaining cellulose: autoclave, capacity 8000 ml; porcelain container with a capacity of 10,000 ml; porcelain cup, capacity 1000 ml; fine mesh strainer; drying cabinet (150^0C).

700 g of crushed sample is thoroughly immersed in 7000 ml of solution (module 1:10) containing 60 g/l of caustic alkali and 0.5 g/l of OP-10 in a porcelain container, autoclaved and

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tightly closed with bolts. Then, with the help of an electric heater, the temperature rises to 150-160^{0}C, at which temperature the waste is boiled for 3 hours. During boiling, the air collected in the autoclave is released 2-3 times with the help of a valve installed on the autoclave cover. At the end of the process, the autoclave is placed in a container of cold water and the temperature is cooled to 60-70^{0}C, then the resulting cellulose is separated from the solution on a mesh strainer by opening the autoclave lid. The resulting product is unbleached cellulose, which is dried at room temperature or on a drying rack at 100^{0}C, and the yield of the product is calculated as a percentage. The amount of ash, the degree of polymerization, the amount of α-cellulose and the amount insoluble in H_2SO_4 were determined.

Table-1. Results of cellulose quality parameters when the boiling process was carried out for 100 minutes

Alkali consumption,%	Product yield, %	Ash content, %	Degree of polymerization	Amount not dissolved in H_2SO_4, %	α-cellulose content, %
5	56,9	1,7	1100	12,0	80,1
10	49,6	1,9	1025	15,1	75,6
15	46,1	2,5	990	16,8	73,6
20	43,0	2,8	975	18,2	70,3

Table-2.Results of cellulose quality parameters when the boiling process was carried out for 120 minutes

Alkali consumption,%	Product yield, %	Ash content, %	Degree of polymerization	Amount not dissolved in H_2SO_4, %	α-cellulose content, %
5	53,12	1,6	950	11,6	80,0
10	48.9	1.8	980	12.6	76.2
15	45.6	2,4	990	16,5	74,6
20	42.6	2,6	1025	17,2	72,3

Table-3. Results of cellulose quality parameters when the boiling process was carried out for 140 minutes

Alkali consumption,%	Product yield, %	Ash content, %	Degree of polymerization	Amount not dissolved in H_2SO_4, %	α-cellulose content, %
5	52,32	1,5	1005	11,5	79,6
10	48,62	1,7	970	11,8	77,6
15	42,62	2,1	950	15,6	75,6
20	40,1	2,3	930	16,2	74,1

Table-4. Results of cellulose quality parameters when the boiling process was carried out for 160 minutes

Alkali consumption,%	Product yield, %	Ash content, %	Degree of polymerization	Amount not dissolved in H_2SO_4, %	α-cellulose content, %
5	51,2	1,5	970	10,9	82,6
10	45,0	1,5	950	11,0	80,1
15	40,9	1,7	910	14,6	79,4
20	39,1	2,1	890	15,3	77,1

The duration of boiling the amaranth stalk for 100, 120, 140, 160 minutes, 5.0 of caustic sodium; 10.0; The change in the degree of polymerization at 15.0, 20% is presented in the graphs below.

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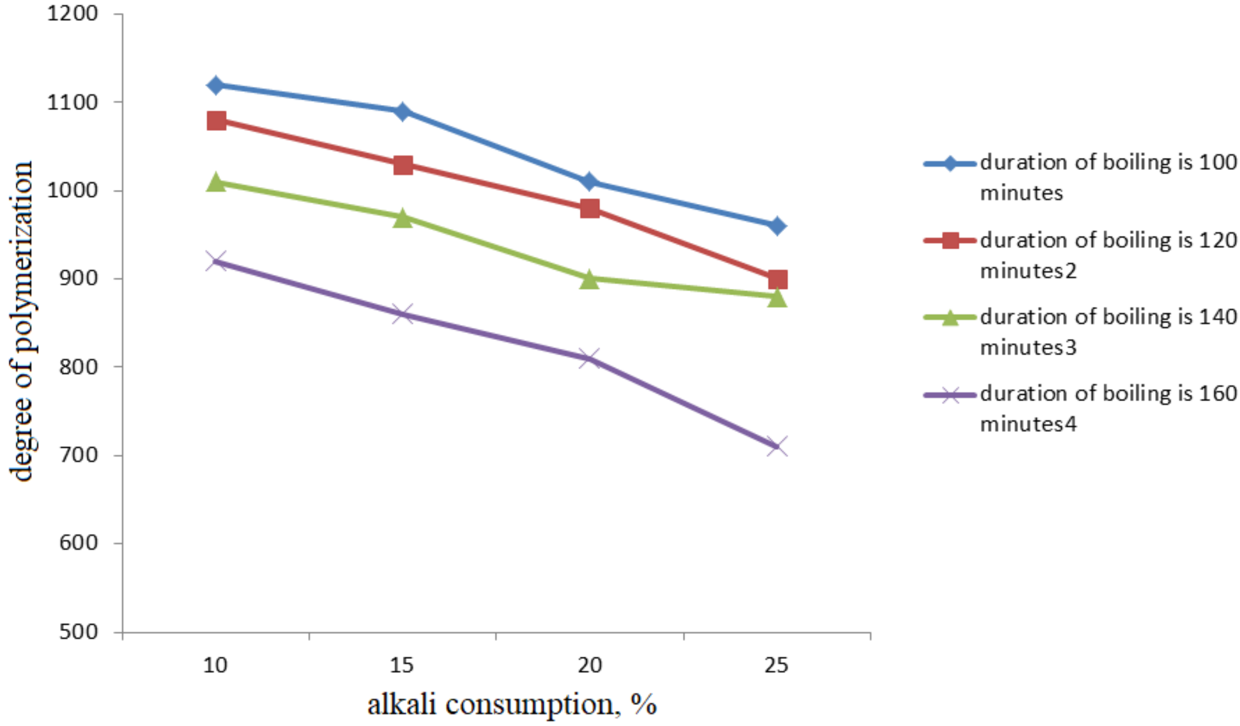

Figure 1. The effect of alkali concentration on the degree of polymerization of cellulose at different boiling times

The temperature is 130-145^{0}C, the duration of boiling is 1-3 hours, during the boiling process, non-cellulosic wastes are decomposed and become soluble, and in this process, fat and waxy compounds are removed from the fiber. The fiber is given a hydrophilic property. After the boiling process is finished, the solution is cooled to 90^{0}C, the pressure in the boiler is reduced to 1-1.5 atm. The washed cellulose is diluted with water to a concentration of 2.5-3% and transferred to the bleaching tank.

During the alkaline treatment, the yellowed vegetable cellulose undergoes a bleaching process (decolorization). The cellulose of the amaranth plant is bleached in a solution of hydrogen peroxide. Neutralization is carried out using a 0.5-4 g/l solution of sulfuric acid.

Cellulose bleaching with hydrogen peroxide depends on the amount of the reagent, the effect of temperature, and the concentration of the mass. When the mass concentration is high, the bleaching speed increases, and the processing time is shortened.

For the bleaching process, a sample of amaranth pulp obtained from wet amaranth is selected. The table below shows the whiteness of cellulose. Note: T - 80^{0}C, t - 60 minutes.

Table-5. NaOH concentration whiteness of cellulose impact on the level

NaOH concentration, %	Degree of whiteness, %, H_2O_2 (8% by mass)
10	70
15	75
20	81

In high-concentration bleaching, it is difficult to prepare special equipment for dewatering and mixing the mass with the solution. Bleaching is at its highest when the hydrogen peroxide solution is at its maximum concentration. When the concentration is higher than 3%, bleaching increases to a higher level, that is, by 10-15%.

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Conclusion

It was proposed to obtain cellulose from amaranth plant by boiling it with 20% alkali in relation to the mass, at a temperature of 135-145^{0}C, for a duration of 140 minutes. During the experiments, it was found that as the concentration of caustic sodium increased, the yield of cellulose decreased from 56.9% to 43.0%, the degree of polymerization decreased from 1110 to 750, the amount of sol decreased from 1.7% to 2.8%, a The amount of -cellulose decreased from 80.1% to 70.3%. Amaranth plant cellulose is bleached in an 8% by mass solution of hydrogen peroxide, in an alkaline environment, at a temperature of 80^{0}C for 60 minutes.

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